HAWAII PRECIPITATION FREQUENCY STUDY

Update of *Technical Paper No. 43*

First Progress Report
1 April through 30 June 2001

Hydrometeorological Design Studies Center
Hydrology Laboratory

Office of Hydrologic Development
U.S. National Weather Service
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DISCLAIMER

The data and information presented in this report should be considered as preliminary and are provided only to demonstrate current progress on the various technical tasks associated with this project. Values presented herein are NOT intended for any other use beyond the scope of this progress report. Anyone using any data or information presented in this report for any purpose other than for what it was intended does so at their own risk.

Acknowledgments

Meteorologists, statisticians, computer experts and support staff have contributed to the Hawaii Precipitation Frequency Study. This includes, but is not limited to, the following people:

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Geoffrey Bonnin, HDSC Leader
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1. Introduction.

The Hydrometeorological Design Studies Center (HDSC), Hydrology Laboratory, Office of Hydrologic Development, U.S. National Weather Service is updating its precipitation frequency analysis for Hawaii. Current precipitation frequency studies for Hawaii are contained in *Technical Paper No. 43,* "Rainfall-Frequency Atlas of the Hawaiian Islands for Areas to 200 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years" (U.S. Weather Bureau 1962). The current study includes collecting data and performing quality control, compiling and formatting datasets for analyses, selecting applicable frequency distributions and fitting techniques, analyzing data, mapping and preparing reports and other documentation.

The study will determine annual and seasonal precipitation frequencies for durations from 5 minutes to 10 days, for return periods from 2 to 1000 years. The study will review and process all available rainfall data for the Hawaii study area and use accepted statistical methods. The study results will be published as a Volume of NOAA Atlas 14. They will also be made available on the internet using web pages with the additional ability to download digital files.

The study area covers the Hawaiian islands including Hawaii, Maui, Kahoolawe, Lanai, Molokai, Oahu, Kauai and Nihau. The study area including preliminary regions is shown in Figure 1.

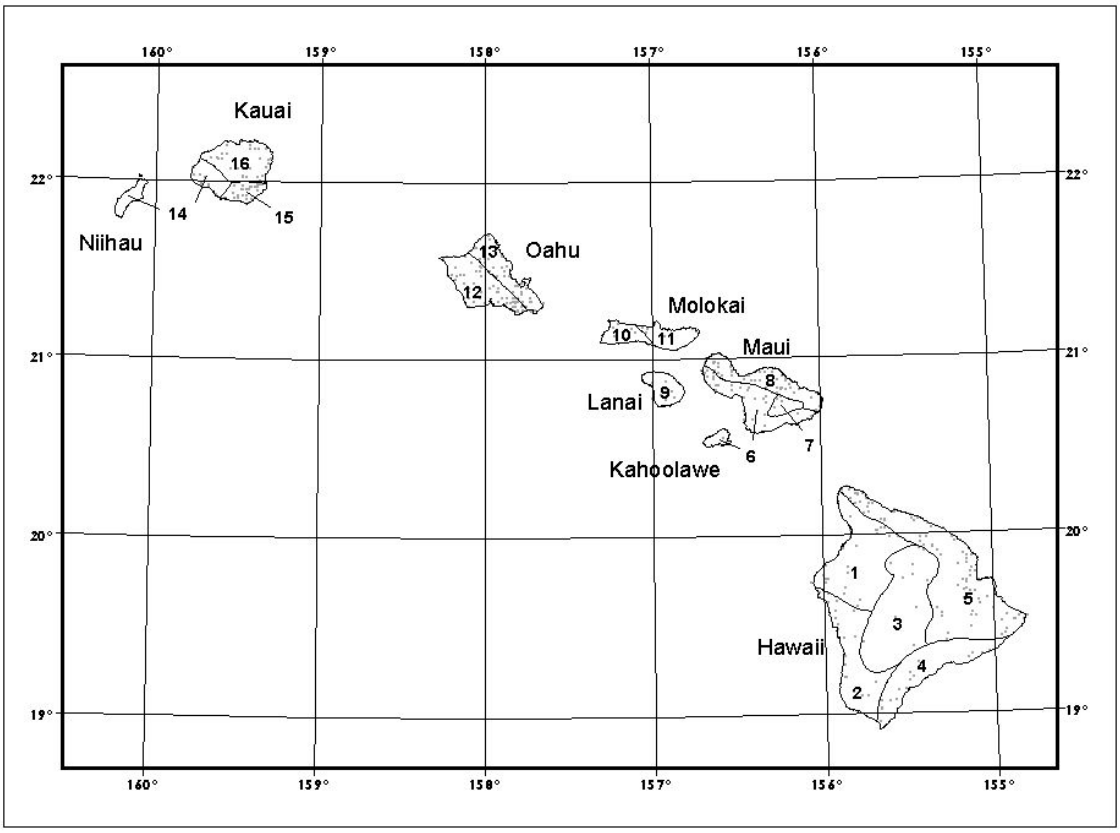

Figure 1. Hawaii Precipitation Frequency study area, region boundaries and Daily station locations.

2. Highlights.

Daily, hourly and n-minute rainfall data have been collected from The National Climatic Data Center (NCDC) and put into a format which is suitable for our use and compatible with previous studies from this office. Hydronet data has been collected and also converted into our format. Hand entry from paper forms has begun for years not covered in the digital NCDC data. Initial elevation and station location maps have been developed. Preliminary regions have been set. Additional information on these topics is provided in Section 4, Progress in this Reporting Period.

The National Weather Service headquarters has reorganized, and the new management has initiated a review of the Hydrometeorological Design Studies Center. Additional information is provided in Section 5.1, Organizational Review by New Management.

3. Status.

3.1 Project Task List.

The following checklist shows the components of each task and an estimate of the percentage completed per task.

Hawaii study checklist [estimated percent complete]:

Data Collection, Formatting and Quality Control [25%]:

- Daily
- Hourly
- N-minute

L-Moment Analysis/Frequency Distribution for 1 hr - 60 days and 2 to 1000 yrs [0%]:

- Daily
- Hourly
- N-minute

Algorithm/Data Plot [5%]

- Establish regions from spatial, topographic and meteorological variables
- Run L-moments for regional growth factors to generate dataset
- Create 2yr-24hr precipitation frequency index map
  - Format dataset
  - Review maps (i.e., station id's, discordancy, elevation, frequency values)
  - Review hand-drawn analysis
  - Perform digitization
  - Rasterization
  - Generate contour rasters for final map
- Create ratio maps - 2yr (1-12) hr/2yr 24hr, 2yr (2-60) day/2yr 24hr
  - Plotting
  - Review hand-drawn analysis
  - Perform digitization
  - Rasterization
- Create regional growth factor maps - 2yr (1-12) hr/2yr 24hr, 2yr (2-60) day/2yr 24hr

Precipitation Frequency Maps [0%]

- Create frequency maps for 1-hour to 60-day durations at return periods 2 to 1000 years (seasonal and annual maximum) by multiplying index map rasters and using appropriate regional growth factor and ratio map rasters
- Create maps and/or relations for durations smaller than 1 hour (5, 10, 15, 30 minute) using index map and appropriate conversion factors
- Perform internal consistency checks (comparing rasters of sequential duration and frequency)

Temporal Distributions of Extreme Rainfall [0%]

- hourly data assembled by quartile of greatest precipitation amount and converted to cumulative rainfall amounts for each region
- graphs of representative storm-types and seasons

Spatial Relations (Depth-Area-Duration Studies) [0%]

- analyze critical storms to determine depth-area-duration relations
- small-area, short-duration relations
- area-depth curves for areas <500 mi^2 and for >500mi^2
- families of mass curves and area-depth curves as a function of duration and area size
- a smoothed set of curves to distinguish between convective, tropical and non-tropical storms (if appropriate)

Deliverables [5%]

- Write hard copy of Final Report
    - Maps of analyzed results
    - Graphical relations to obtain intermediate values
    - Seasonal variation
    - Depth-area distribution
    - Temporal distribution of rainfall in extreme storms
    - Implement peer review
- Prepare data for web delivery
- Prepare documentation for web delivery
- Publish hard copy of Final Report

3.1.1 Data Collection and Quality Control.

The daily and hourly datasets have been updated through December 1999 and the n-minute dataset through May 1997. We are in the process of adding data to the daily, hourly and n-minute stations through December 2000. The Hydronet (15-minute) data through December 2000 has been downloaded and formatted but not yet entirely quality controlled. Hydronet is the name given to a statewide system of NWS maintained, telemetered tipping bucket rain gages separate from NCDC gages.

Table 1 shows a breakdown of the types of data we have compiled from NCDC and Hydronet digital datasets. The NCDC daily, hourly and n-minute datasets do not yet include hand entered data. Once hand entered data is included the record lengths will increase. The NCDC digital data starts in 1949 and the Hydronet data starts in 1994.

Table 1. Number of stations and record lengths for daily, hourly, n-minute and Hydronet datasets.

	Daily	**Hourly**	**N-minute**	**Hydronet**
No. of stations	466	140	3	70
Longest record length (yrs), station number and name	51 (51-9980) WILHELMINA RISE	38 (51-5580) LIHUE WSO AP	25 (51-5580) LIHUE WSO AP	7 (most stations have 7 years)
Average record length (yrs)	29	20	18	7

3.1.2 Mapping Analyses.

HDSC continues to explore the possibility of using spatial interpolation tools such as the Parameter-elevation Regressions on Independent Slopes Model (PRISM). Discussions with the Spatial Climate Analysis Center will determine if there are ways to adapt PRISM technology for use with precipitation frequency data.

3.1.3 Documentation and Publication.

The Hawaii study results will be available on the HDSC Precipitation Frequency Data Server once mapping is complete. The Data Server displays precipitation frequency values and intensity-duration-frequency curves and tables. At present, all 50

states can be selected. Where studies are not yet concluded, such as Hawaii, information on existing precipitation frequency maps, namely Technical Paper No. 43 (U.S. Weather Bureau 1962) is given.

4. Progress in this Reporting Period.

4.1 Data Collection

Daily, hourly and n-minute rainfall data has been collected from NCDC and put into a format which is suitable for our use and compatible with previous studies from this office. Data has been collected from the Hydronet web site (http://www.nws.noaa.gov/pr/hnl/hydro/hydronet/hydronet-data.htm) and also formatted. Hydronet is the name given to a statewide system of NWS maintained, telemetered tipping bucket rain gages. We are also in the process of acquiring additional 15-minute data from the State Climatologist to enhance our spatial and temporal coverage. Ideally, 20 continuous data years are needed at a station to provide reasonable Precipitation Frequency results.

The Hydronet data required extensive work in order to suit our needs. Besides reformatting the columns, details such as full gages resetting to zero had to be manually found and changed back to a continuous format like the NCDC data. Some quality control (QC) has been done on all the data but extensive QC on extremes has just begun.

To increase the record length of the NCDC digital daily data, hand data entry has begun. NCDC digital records begin around 1949 while data recorded on paper begins before 1900 for some stations. This will add 40 or more years to some daily stations.

4.2 Regionalization

Preliminary Precipitation Frequency regions have been drawn and digitized. Histograms, which are graphs depicting the number of monthly maximums, were developed for stations across the Islands (Figure 2). Based on these histograms and knowledge of the rainfall climatology of Hawaii, homogeneous regions of maximum precipitation were developed. Homogeneous regions are critical for our L-Moment statistical procedures.

Digital maps of elevation were obtained and printed for use in future analyses for this study. Maps of station location were also plotted. These station locations and elevations were checked to be sure the databases were correct and matched each other . Station locations were also scrutinized to determine where supplemental State gage information would help the spatial distribution.

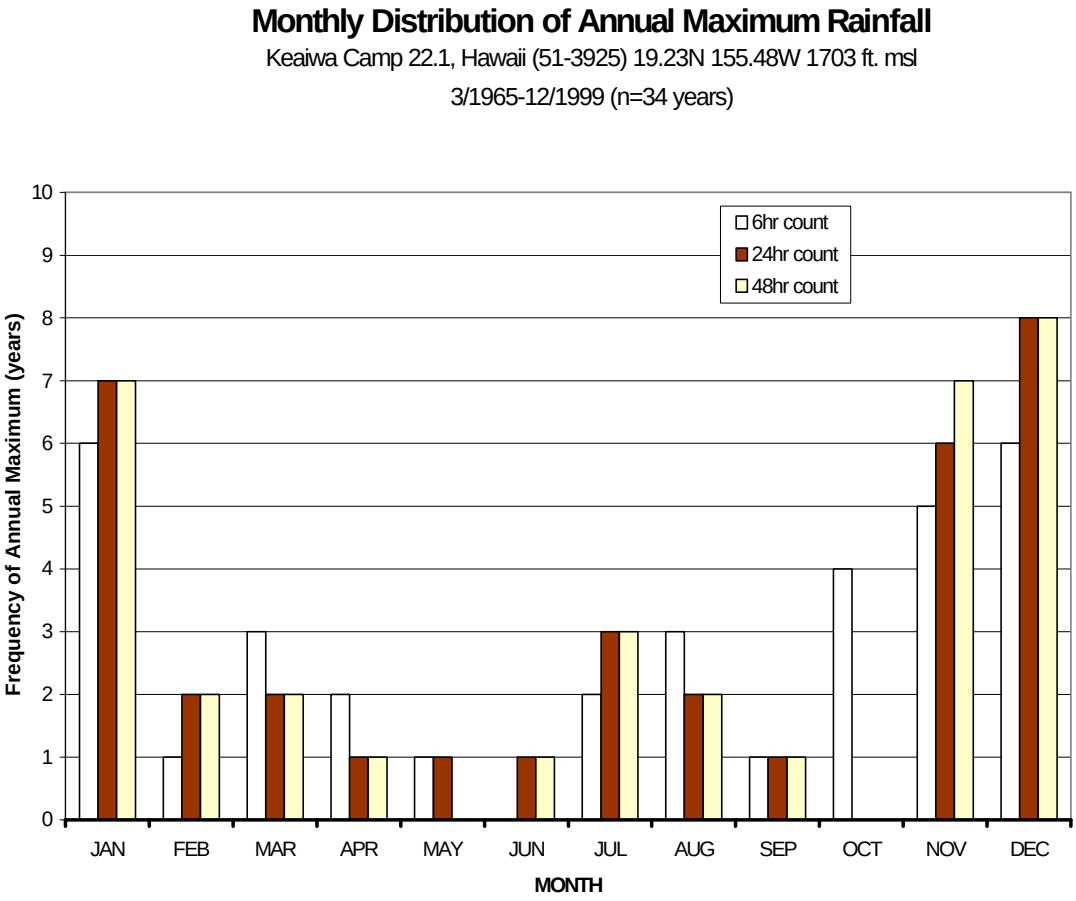

Figure 2. Monthly Distribution of Annual Maximum Rainfall from Hourly Station Keaiwa Camp 22.1.

5. Issues.

5.1 Organizational Review by New Management.

The National Weather Service headquarters has reorganized (details can be viewed at http://www.nws.noaa.gov/oh/start.html). The new management has initiated review of the Hydrometeorological Design Studies Center.

5.1.1 Technology

A committee of technical experts from our partners is reviewing the technology we are using for precipitation frequency analysis. The committee members are:

Rocky Durrans, The University of Alabama, Tuscaloosa, AL (Rapporteur)
Greg Johnson, USDA-NRCS National Water and Climate Center, Portland, OR
Lou Schreiner, U.S. Bureau of Reclamation, Lakewood, CO
Jim Angel, Illinois State Water Survey, Champaign, IL (representing the American Association of State Climatologists)
Art DeGaetano, Northeast Regional Climate Center, Ithaca, NY
Will Thomas, Michael Baker Corporation, Alexandria, VA (representing the Transportation Research Board)
David Goldman, U.S. Army Corps of Engineers, Davis, California
Alan McNab, National Climatic Data Center, Asheville, NC
Geoff Bonnin, NWS Office of Hydrologic Development, Silver Spring, MD (Chairman)

The committee is looking at:

A. Data Collection and Quality Control: The committee suggested NWS contract for the data collection and quality control work. To that end, the Northeast Regional Climate Center has submitted a proposal combining the expertise of each of the regional climate centers. Since the data collection and quality control work for the Hawaii Precipitation Frequency Study is almost complete, there will be no impact on this study.

B. Statistical Analysis Procedure: The committee recommended a panel of recognized experts review the procedures. The NWS is currently responding to the first round of review comments. The NWS expects the statistical analysis procedures to be validated with perhaps minor adjustments. We do not expect any impact on the Hawaii Precipitation Frequency Study.

C. Spatial Interpolation: The committee recommended discussions with the Spatial

Climate Analysis Center to determine if there are ways to adapt PRISM technology to precipitation frequency data.

5.1.2 Funding and Schedule

The technical committee recommended that precipitation frequencies for the entire United States be updated within three years. While the management review is not yet final there is a significant concern about whether the funds available are consistent with these expectations and whether current schedules are realistic.

6. Projected Schedule.

The following list provides a tentative schedule with completion dates. Brief descriptions of tasks being worked on in the next quarter are also included in this section.

Data Collection and Quality Control [November 2001]
L-Moment Analysis/Frequency Distribution [January 2002]
Algorithm/Data Plot [February 2002]
Precipitation Frequency Maps [March 2002]
Temporal Distributions of Extreme Rainfall [May 2002]
Spatial Relations (Depth-Area-Duration Studies) [May 2002]
Implement review by peers [June 2002]
Write hard copy of Final Report [July 2002]
Publish hard copy of Final Report [September 2002]

6.1 Data Collection and Quality Control.

Daily and hourly station data up through December 2000 will be added to the dataset and included in the precipitation frequency calculations. The current dataset contains station data from the NCDC and the NWS Hawaii. NCDC data before 1949 will be hand entered into the daily data set. Quality control of extreme values will continue.

The Hawaii State Climatologist's office has indicated they have data to add to our dataset. Discussions have been ongoing to determine what part of these data would be useful to the study. These data would need to be hand entered. The time that would be required to hand enter this data would put the Hawaii Precipitation Frequency study on hold until the entry is completed.

6.2 Precipitation Frequency Maps.

A sophisticated cartographic-map making process has been designed using the recently released GIS software, ArcView 8.1. During the next few months a review and revision process will result in a final cartographic-quality map template. This map template will then serve as the basis for all future precipitation frequency maps. The maps will be available online as postscript, ArcInfo ASCII raster, ArcView Shape, and JPEG files. The maps will also be made available in a hardcopy form as a Volume of NOAA Atlas 14.

6.3 Precipitation Frequency Data Server.

Once the data and mapping are complete, the precipitation frequency estimates for the Hawaii study will be available from the newly developed HDSC web-based Precipitation Frequency Data Server. The Data Server will display precipitation frequency values, as well as intensity-duration-frequency (IDF) curves and tables. Eventually, all states will be selectable from the opening U.S. map.

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